



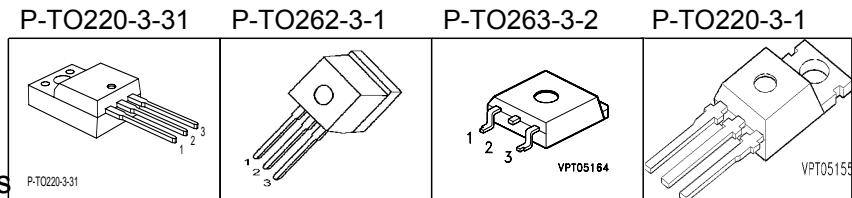
Final data

**SPP21N50C3, SPB21N50C3  
SPI21N50C3, SPA21N50C3**

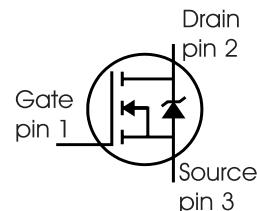
## Cool MOS™ Power Transistor

### Feature

- New revolutionary high voltage technology
- Worldwide best  $R_{DS(on)}$  in TO 220
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- P-TO-220-3-31: Fully isolated package (2500 VAC; 1 minute)



Type	Package	Ordering Code	Marking
SPP21N50C3	P-TO220-3-1	Q67040-S4565	21N50C3
SPB21N50C3	P-TO263-3-2	Q67040-S4566	21N50C3
SPI21N50C3	P-TO262-3-1	Q67040-S4564	21N50C3
SPA21N50C3	P-TO220-3-31	Q67040-S4585	21N50C3



### Maximum Ratings

Parameter	Symbol	Value		Unit
		SPP_BBI	SPA	
Continuous drain current $T_C = 25^\circ\text{C}$	$I_D$	21	21 <sup>1)</sup>	A
$T_C = 100^\circ\text{C}$		13.1	13.1 <sup>1)</sup>	
Pulsed drain current, $t_p$ limited by $T_{jmax}$	$I_{D \text{ puls}}$	63	63	A
Avalanche energy, single pulse $I_D=10\text{A}, V_{DD}=50\text{V}$	$E_{AS}$	690	690	mJ
Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ <sup>2)</sup> $I_D=21\text{A}, V_{DD}=50\text{V}$	$E_{AR}$	1	1	
Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$	$I_{AR}$	21	21	A
Gate source voltage	$V_{GS}$	$\pm 20$	$\pm 20$	V
Gate source voltage AC ( $f > 1\text{Hz}$ )	$V_{GS}$	$\pm 30$	$\pm 30$	
Power dissipation, $T_C = 25^\circ\text{C}$	$P_{tot}$	208	34.5	W
Operating and storage temperature	$T_j, T_{stg}$	$-55...+150$		°C

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 400 \text{ V}$ , $I_D = 21 \text{ A}$ , $T_j = 125^\circ\text{C}$	$dv/dt$	50	V/ns

**Thermal Characteristics**

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.6	K/W
Thermal resistance, junction - case, FullPAK	$R_{thJC\_FP}$	-	-	3.6	
Thermal resistance, junction - ambient, leaded	$R_{thJA}$	-	-	62	
Thermal resistance, junction - ambient, FullPAK	$R_{thJA\_FP}$	-	-	80	
SMD version, device on PCB: @ min. footprint @ 6 cm <sup>2</sup> cooling area <sup>3)</sup>	$R_{thJA}$	-	-	62	°C
Soldering temperature, 1.6 mm (0.063 in.) from case for 10s <sup>4)</sup>	$T_{sold}$	-	-	260	

**Electrical Characteristics**, at  $T_j=25^\circ\text{C}$  unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{V}$ , $I_D=0.25\text{mA}$	500	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}$ , $I_D=21\text{A}$	-	600	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=1000\mu\text{A}$ , $V_{GS}=V_D$	2.1	3	3.9	$\mu\text{A}$
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=500\text{V}$ , $V_{GS}=0\text{V}$ , $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.1	1	
Gate-source leakage current	$I_{GSS}$	$V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$ , $I_D=13.1\text{A}$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.16	0.19	$\Omega$
Gate input resistance	$R_G$	f=1MHz, open drain	-	0.54	-	

**Electrical Characteristics**

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	$g_{fs}$	$V_{DS} \geq 2 * I_D * R_{DS(on)max}$ , $I_D = 13.1A$	-	18	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0V, V_{DS} = 25V$ , $f = 1MHz$	-	2400	-	pF
Output capacitance	$C_{oss}$		-	1200	-	
Reverse transfer capacitance	$C_{rss}$		-	30	-	
Effective output capacitance, <sup>5)</sup> energy related	$C_{o(er)}$	$V_{GS} = 0V, V_{DS} = 400V$	-	87	-	
Effective output capacitance, <sup>6)</sup> time related	$C_{o(tr)}$		-	181	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380V, V_{GS} = 0/10V$ , $I_D = 21A$ , $R_G = 3.6\Omega$	-	10	-	ns
Rise time	$t_r$		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	67	-	
Fall time	$t_f$		-	4.5	-	

**Gate Charge Characteristics**

Gate to source charge	$Q_{gs}$	$V_{DD} = 380V, I_D = 21A$	-	10	-	nC
Gate to drain charge	$Q_{gd}$		-	50	-	
Gate charge total	$Q_g$	$V_{DD} = 380V, I_D = 21A$ , $V_{GS} = 0$ to $10V$	-	95	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 380V, I_D = 21A$	-	5	-	V

<sup>1</sup>Limited only by maximum temperature

<sup>2</sup>Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV} = E_{AR} * f$ .

<sup>3</sup>Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air.

<sup>4</sup>Soldering temperature for TO-263: 220°C, reflow

<sup>5</sup> $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

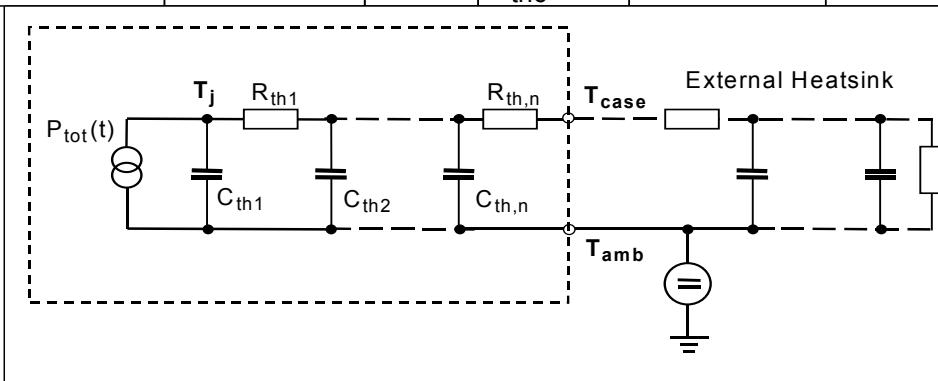
<sup>6</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

**Electrical Characteristics**

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	$I_S$	$T_C=25^\circ\text{C}$	-	-	21	A
Inverse diode direct current, pulsed	$I_{SM}$		-	-	63	
Inverse diode forward voltage	$V_{SD}$	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=380\text{V}, I_F=I_S, di_F/dt=100\text{A}/\mu\text{s}$	-	450	-	ns
Reverse recovery charge	$Q_{rr}$		-	9	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	60	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$	$T_j=25^\circ\text{C}$	-	1200	-	$\text{A}/\mu\text{s}$

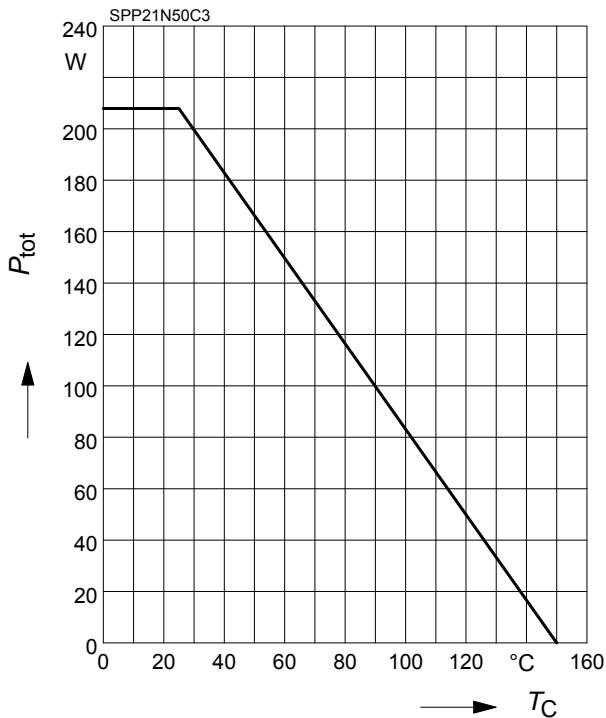
**Typical Transient Thermal Characteristics**

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_B_I	SPA			SPP_B_I	SPA	
$R_{th1}$	0.00769	0.00769	K/W	$C_{th1}$	0.0003763	0.0003763	Ws/K
$R_{th2}$	0.015	0.015		$C_{th2}$	0.001411	0.001411	
$R_{th3}$	0.029	0.029		$C_{th3}$	0.001931	0.001931	
$R_{th4}$	0.114	0.16		$C_{th4}$	0.005297	0.005297	
$R_{th5}$	0.136	0.319		$C_{th5}$	0.012	0.008659	
$R_{th6}$	0.059	2.523		$C_{th6}$	0.091	0.412	



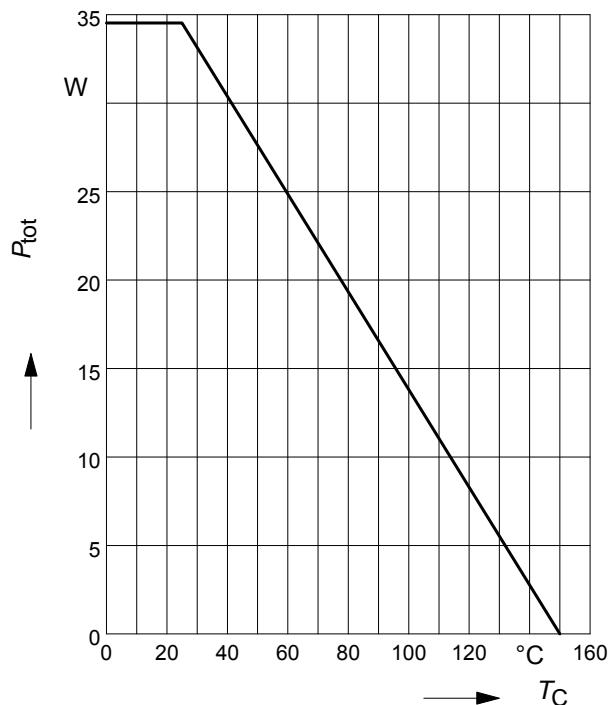
### 1 Power dissipation

$$P_{\text{tot}} = f(T_C)$$



### 2 Power dissipation FullPAK

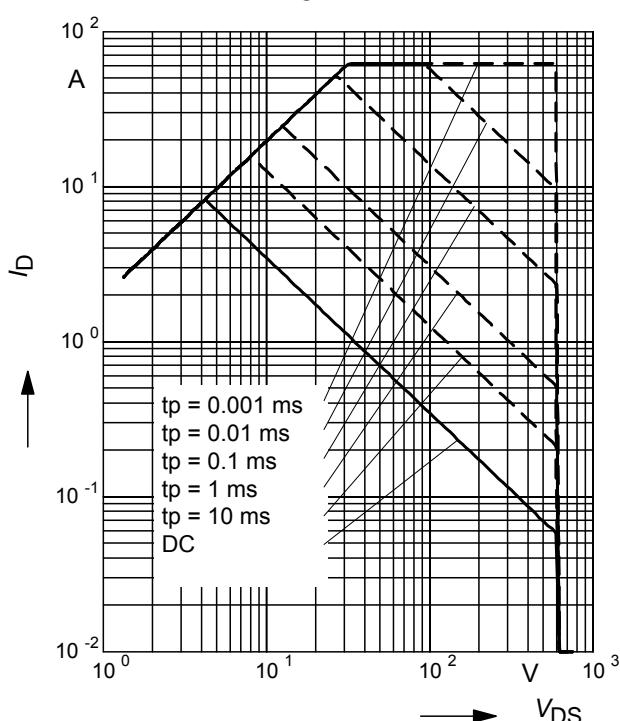
$$P_{\text{tot}} = f(T_C)$$



### 3 Safe operating area

$$I_D = f(V_{DS})$$

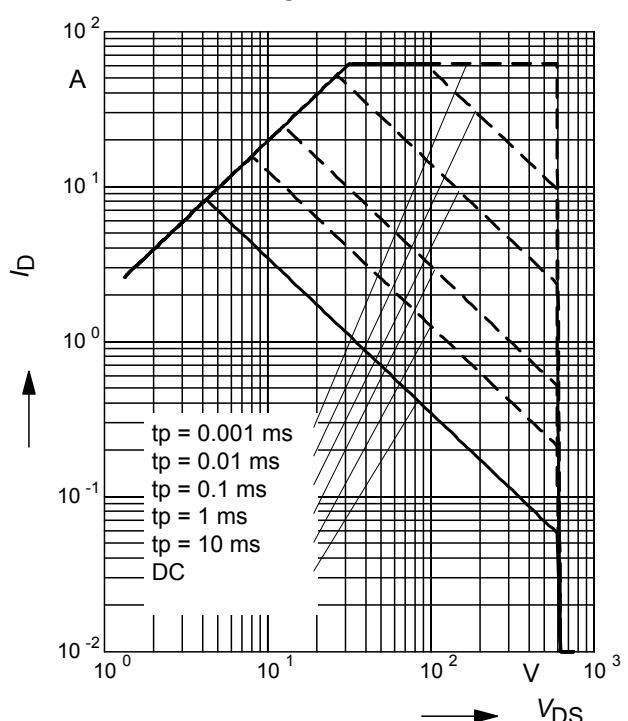
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



### 4 Safe operating area FullPAK

$$I_D = f(V_{DS})$$

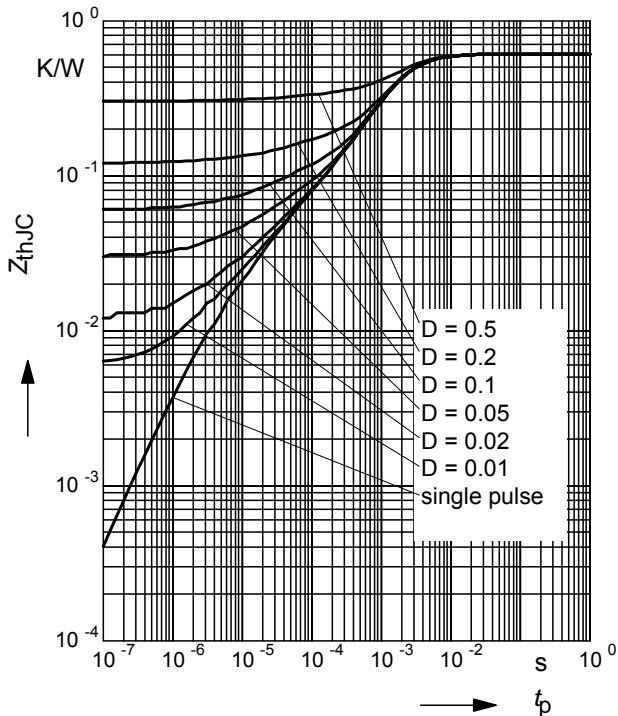
parameter:  $D = 0$ ,  $T_C = 25^\circ\text{C}$



## 5 Transient thermal impedance

$$Z_{\text{thJC}} = f(t_p)$$

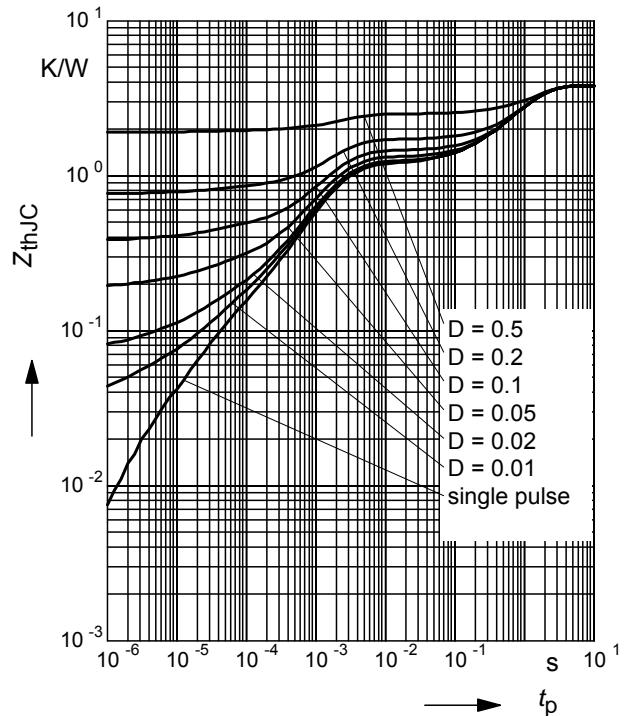
parameter:  $D = t_p/T$



## 6 Transient thermal impedance FullPAK

$$Z_{\text{thJC}} = f(t_p)$$

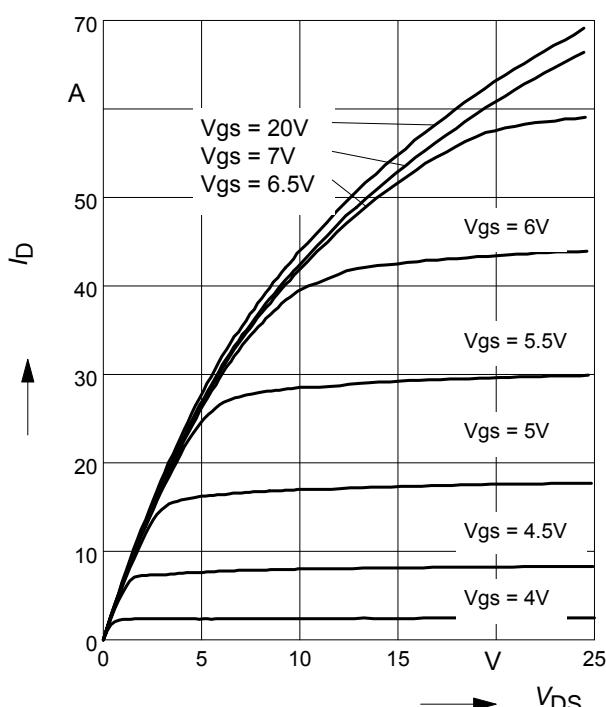
parameter:  $D = t_p/t$



## 7 Typ. output characteristic

$$I_D = f(V_{DS}); \quad T_j=25^\circ\text{C}$$

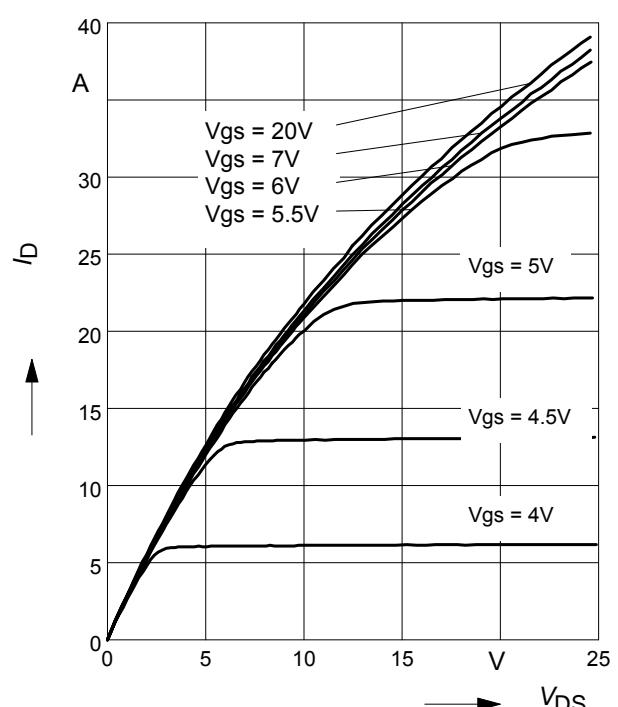
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



## 8 Typ. output characteristic

$$I_D = f(V_{DS}); \quad T_j=150^\circ\text{C}$$

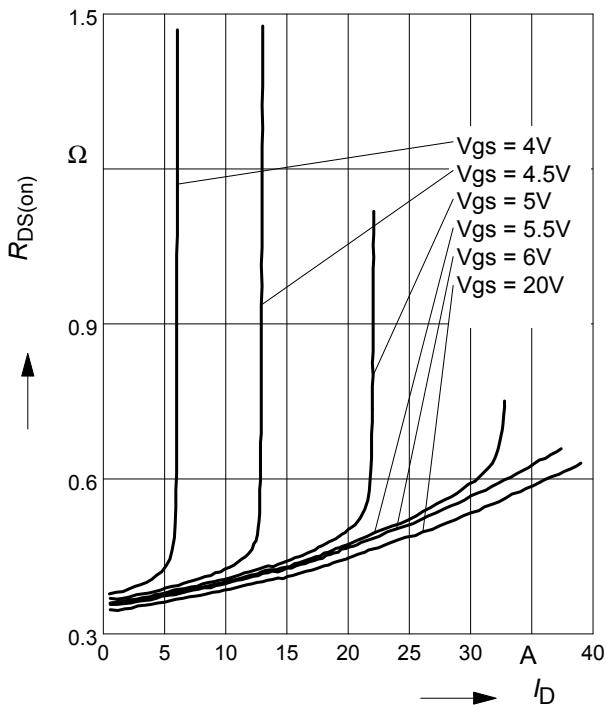
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



### 9 Typ. drain-source on resistance

$$R_{DS(on)} = f(I_D)$$

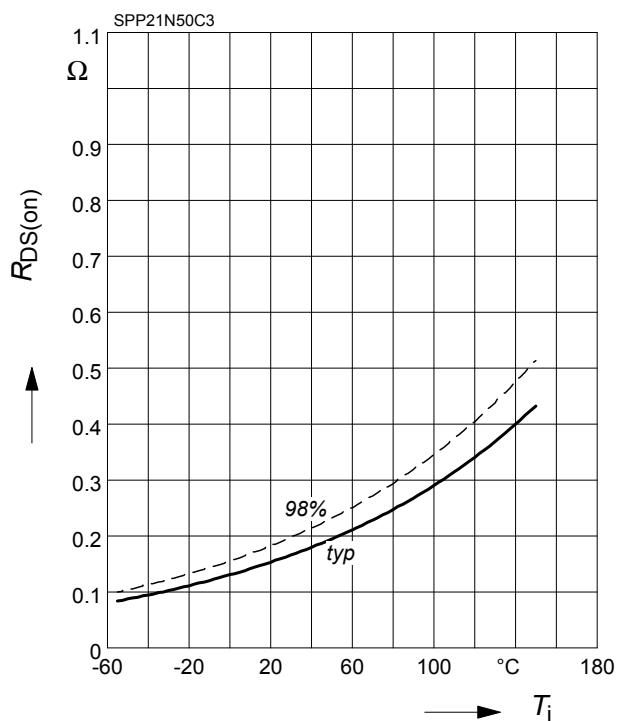
parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$



### 10 Drain-source on-state resistance

$$R_{DS(on)} = f(T_j)$$

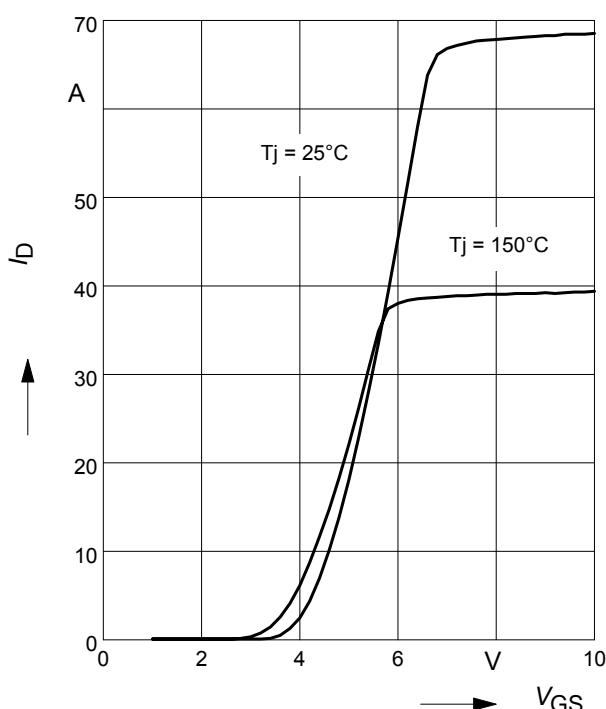
parameter :  $I_D = 13.1 \text{ A}$ ,  $V_{GS} = 10 \text{ V}$



### 11 Typ. transfer characteristics

$$I_D = f(V_{GS}) ; V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$$

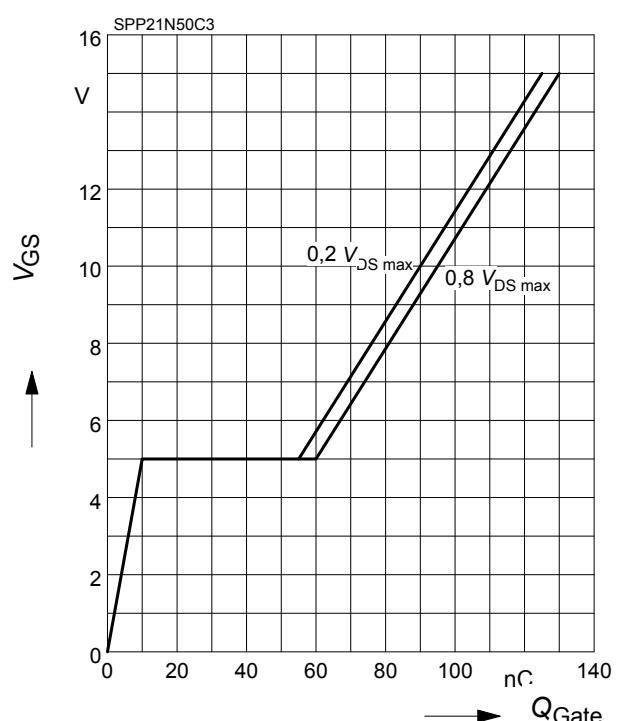
parameter:  $t_p = 10 \mu\text{s}$



### 12 Typ. gate charge

$$V_{GS} = f(Q_{Gate})$$

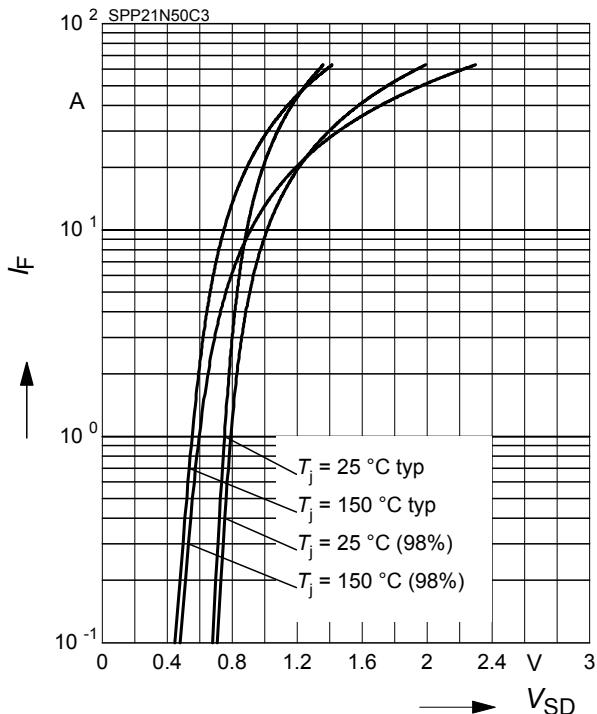
parameter:  $I_D = 21 \text{ A}$  pulsed



### 13 Forward characteristics of body diode

$$I_F = f(V_{SD})$$

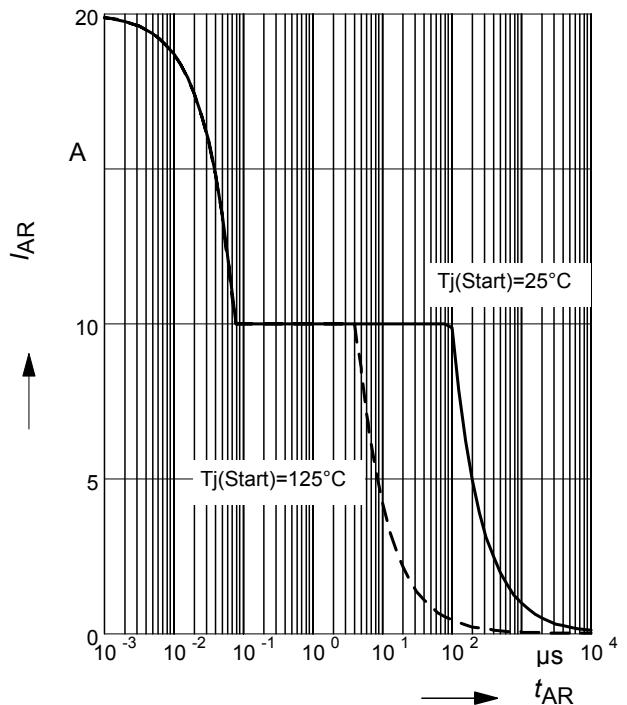
parameter:  $T_j$ ,  $t_p = 10 \mu\text{s}$



### 14 Avalanche SOA

$$I_{AR} = f(t_{AR})$$

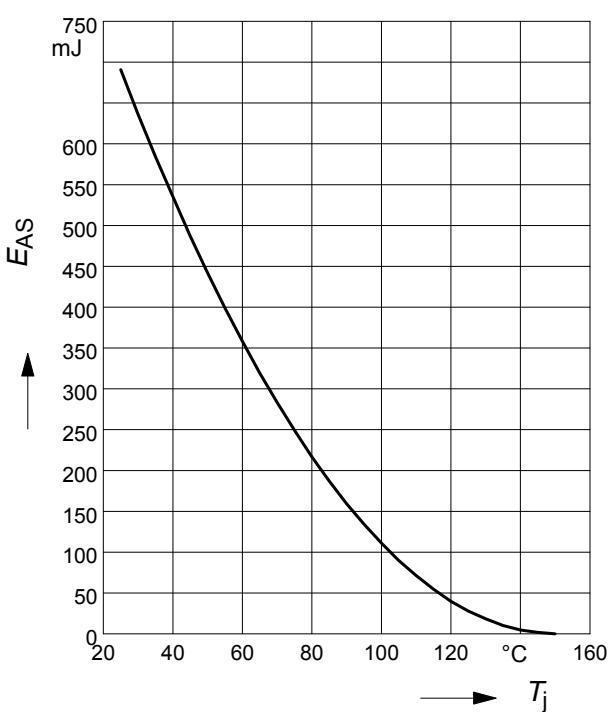
par.:  $T_j \leq 150^\circ\text{C}$



### 15 Avalanche energy

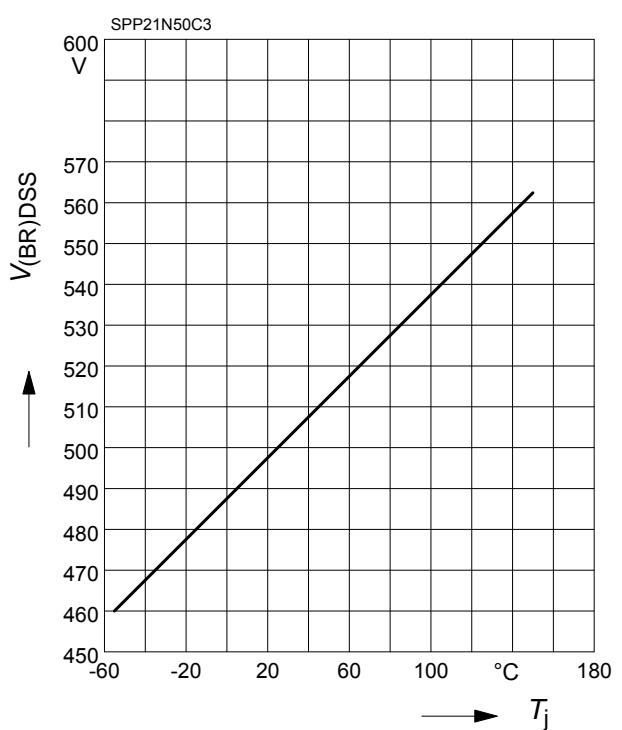
$$E_{AS} = f(T_j)$$

par.:  $I_D = 10 \text{ A}$ ,  $V_{DD} = 50 \text{ V}$



### 16 Drain-source breakdown voltage

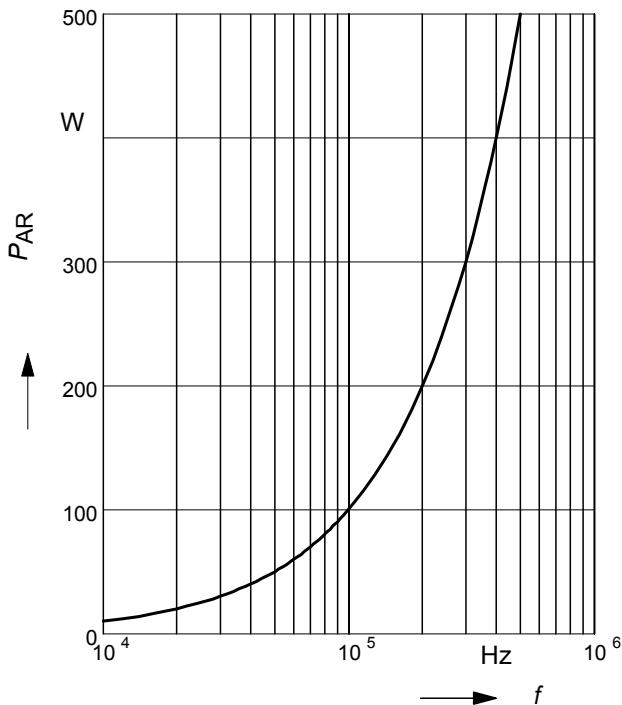
$$V_{(BR)DSS} = f(T_j)$$



**17 Avalanche power losses**

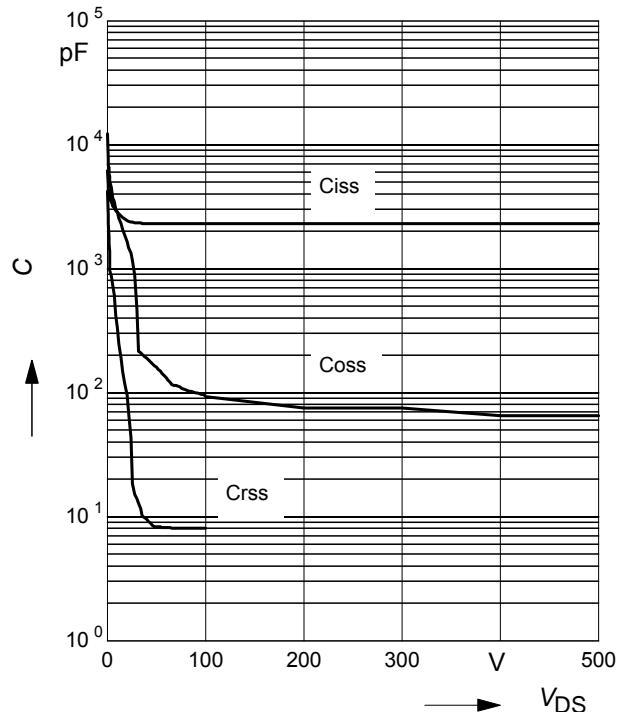
$$P_{AR} = f(f)$$

parameter:  $E_{AR}=1\text{mJ}$

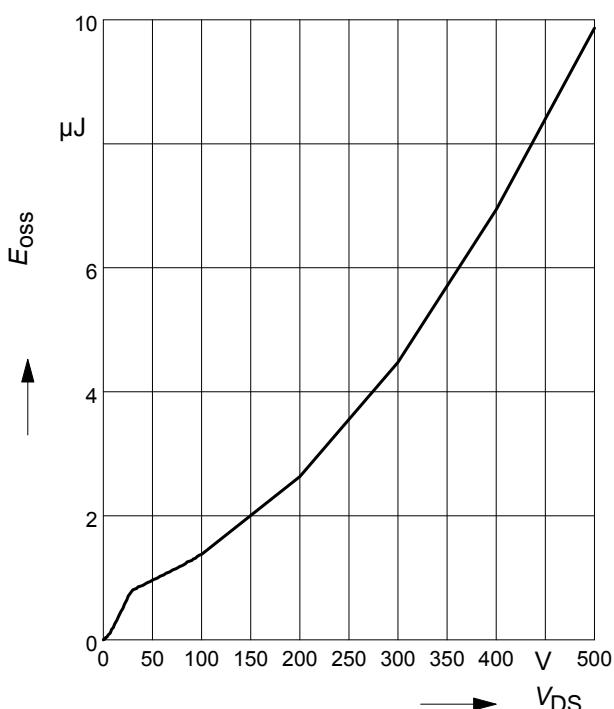

**18 Typ. capacitances**

$$C = f(V_{DS})$$

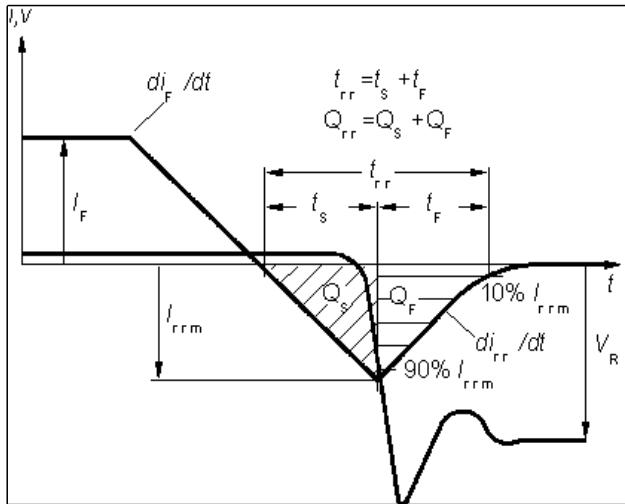
parameter:  $V_{GS}=0\text{V}$ ,  $f=1\text{ MHz}$

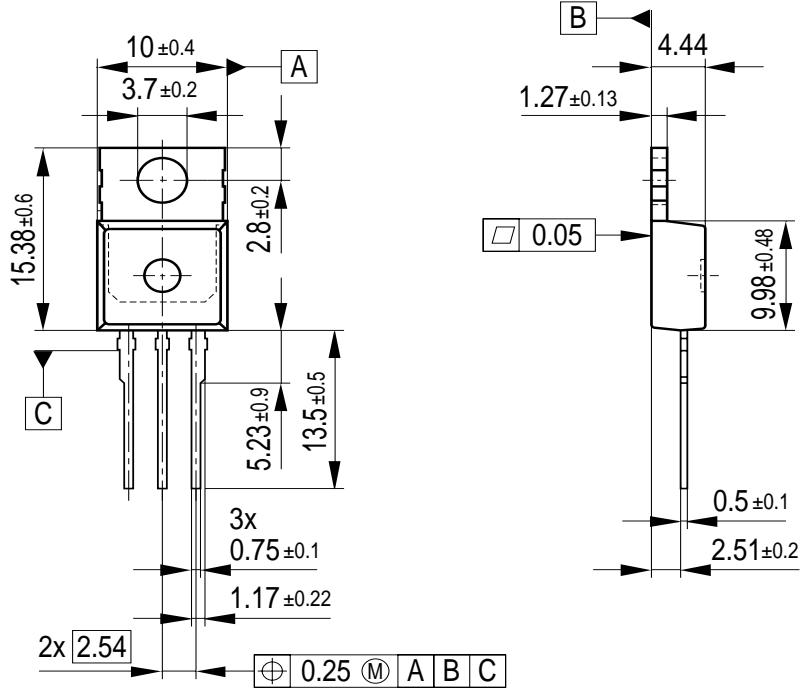

**19 Typ.  $C_{oss}$  stored energy**

$$E_{oss}=f(V_{DS})$$

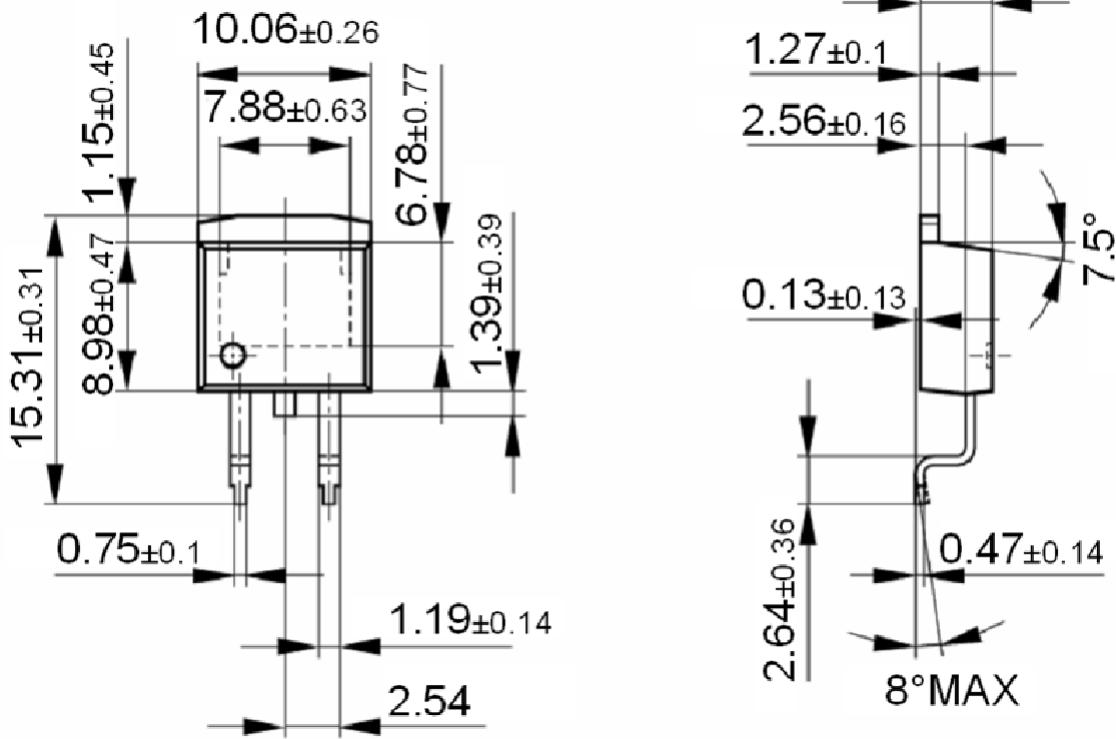


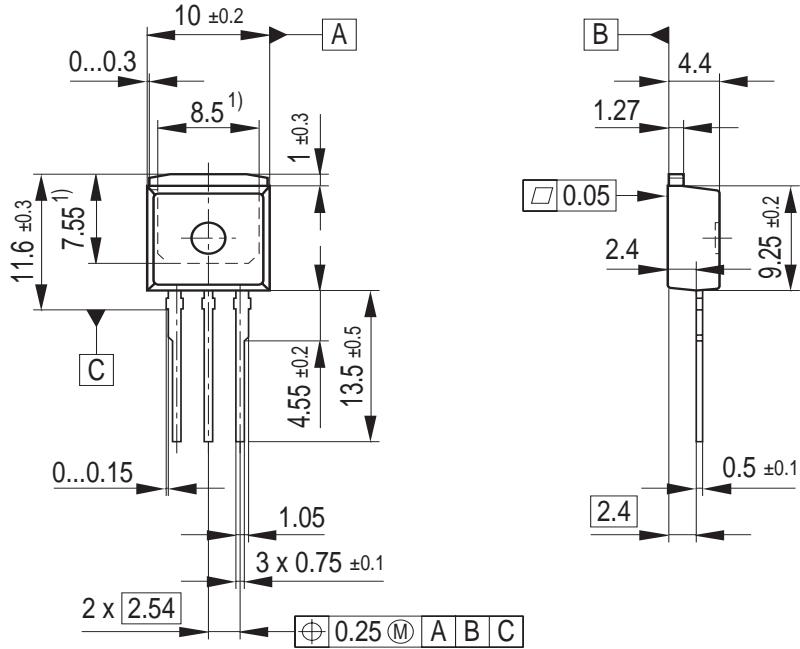
### Definition of diodes switching characteristics



**P-TO-220-3-1**


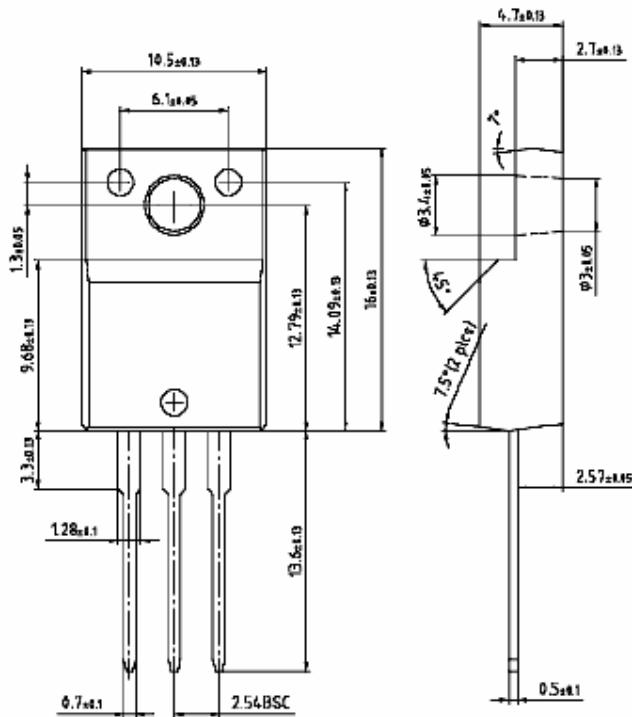
All metal surfaces tin plated, except area of cut.  
Metal surface min. x=7.25, y=12.3

**P-TO-263-3-2 (D<sup>2</sup>-PAK)**


**P-TO-262-3-1 (I<sup>2</sup>-PAK)**

<sup>1)</sup> Typical

Metal surface min. X = 7.25, Y = 6.9

All metal surfaces tin plated, except area of cut.

**P-TO-220-3-31 (FullPAK)**


Please refer to mounting instructions (application note AN-TO220-3-31-01)

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